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Growth Study and Normal Yield Tables for Second Growth Hardwood Stands in Central New England

BY

J. NELSON SPAETH

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CONTENTS

SUMMARY OF CONCLUSIONS

For even-aged second growth hardwood stands in Central New England this study leads to the following conclusions:

I. After cutting the mixed hardwood type regenerates itself substantially unchanged and generally follows the logging of pine stands. The type is, therefore, greatly on the increase in the region.

II. At seventy years on the better sites fully stocked stands produce twenty thousand and on the poorer thirteen thousand board feet of saw timber.

III. In spite of wide variation in percentages of species in mixture, for a given age, site, and density the volume in board feet, cubic feet, and cords is constant.

IV. The volume of a tree of given height and diameter in cords and cubic feet is the same regardless of species.

GROWTH STUDY AND NORMAL YIELD TABLES FOR SECOND GROWTH HARDWOOD STANDS IN CENTRAL NEW ENGLAND

INTRODUCTION

THE present growth study and accompanying yield tables relate to forest types which, though of great and ever increasing importance in the economic life of Central New England, have thus far received but little attention. Situated in the transition belt between the northern hardwood forests of New Hampshire and Vermont and the "sprout" hardwood forests of Connecticut, they combine characteristics of each.

The numerous woodworking industries of the smaller towns and cities furnish a ready outlet for all classes of timber and the use of hardwood in the region, already varied, is rapidly increasing. At present the local hardwood supply is by no means sufficient to satisfy the demand, but hardwood acreage is on the increase due to the tendency of pine lots when cut to reproduce to hardwood. Through simple silvicultural operations, such as have been developed on the Harvard Forest,[1] future stands of this type can be greatly improved as to percent of the more valuable species in mixture, density of stocking and form of trees. The cost of such operations has been shown to be thoroughly justified by the increased value of stands so handled. Since the accompanying tables are based on the actual volumes of fully-stocked, natural stands they represent the minimum to be expected under forest management.

[1] For full discussion of these operations see article by R. T. Fisher, "The Yield of Volunteer Second Growth as Affected by Improvement Cutting and Early Weeding." *Journal of Forestry*, vol. 16, May 1918.

THE REGION

Owing to the range in elevation and variety of soils it is difficult to give accurate geographic boundaries for the region to which this study is applicable. In general, second growth hardwood stands of the types studied occur over central and western Massachusetts, southern Vermont and New Hampshire and northern Connecticut, "sprout" hardwoods extending north in the valleys and northern hardwoods south on the hills.

In north-central Massachusetts, where the field data were gathered, stands reach their optimum on moist benches and gentle slopes at low elevations. East of the Connecticut River valley bottoms average 650 feet in elevation above sea level and the elongated granite, syenite and gneissoid ridges 1150 feet in altitude, their long axes being roughly north and south. Escarpments from a few feet to a hundred or more in height are not uncommon. West of the Connecticut the topography becomes gradually more broken until in the Berkshires it is mountainous, with Greylock rising to the height of 3600 feet.

The soils are mostly glacial in origin, ranging from deep, fertile agricultural land with few boulders (but a small portion of the area is of this type except for the valley floors of the Connecticut and tributary streams) to very thin, bouldery deposits on the bed rock of the ridge-tops and steep slopes almost exclusively covered with huge, angular fragments. There is a distinct tendency toward sandy rather than clay loams with a great abundance of loose rock and boulders of all sizes. Considerable areas of sand plain are occasional. With the exception of the Connecticut River valley some seven-tenths of the area is absolute forest land, either because of its low fertility, steep slope, or abundance of large boulders.

FIGURE 2. Sapling White Ash, Red Oak, and Hard Maple Ten Years after Cutting a Previous Crop of Sixty-five Year Old White Pine. Stand Freed of Inferior Species by Two Weedings.

THE FOREST

The original forest, covering over ninety per cent of the area, was a transitional belt between the Northern and Central Hardwoods, in which sugar maple, beech, yellow birch, white and black ashes, paper birch, black cherry, basswood, poplar, elm, red maple, red spruce and red pine of the Northern Forest intermingled with chestnut, red, black, scarlet, chestnut and white oaks, black birch, hickory and tupelo. Isolated fragments of this forest still exist and seem to indicate that hemlocks and white pines were everywhere scattered through it, either as individuals or in small groups.

Seventy years ago at least half of the area now wooded was cleared land. The opening up of the West in conjunction with the Civil War caused the abandonment of the less productive farms a little over a half century ago. The present forest types are to a greater or lesser extent transitional, resulting from the human occupation of the land. Three types are important, better second growth hardwoods, inferior second growth hardwoods, and second growth pine. Of these the first most nearly approaches the climax type to which all others tend to revert, differing from it somewhat in the proportions of the various species in mixture and in being even-aged and partly of sprout rather than seedling origin.

The second growth pine type (from fifty to one hundred per cent white pine) follows directly the abandonment of land cleared for agriculture and may be succeeded by either of the hardwood types. If cut at the age of fifty years or more a stand of better second growth hardwood results from the advanced hardwood growth which, at that age, has become established under the pine stand. If cut at an age under fifty years an inferior second growth hardwood stand results, due to the lack of hardwood advanced growth and the subsequent reproduction by light seeded species. If left beyond maturity the hardwoods would probably gain a place in the dominant stand and there would result a climax forest of

uneven-aged better hardwoods of seedling origin in which there might be scattered pine and hemlock.

A better second growth hardwood stand (one in which the better timber trees such as red oak, white ash, sugar maple, yellow birch, etc., predominate) follows the clear cutting of a previous stand of similar composition and is largely of sprout origin or follows the cutting of a pine stand over fifty years of age and is largely of seedling and seedling-sprout origin. As shown by observations on the Harvard Forest, when a pine stand is cut in a seed year (*i. e.*, the autumn or winter following a heavy fall of seed) great numbers of pine seedlings (20,000 to 40,000 per acre) cover the area the following spring. Hardwood competition during the early life of the new stand is so strong, however, that it is only in rare instances that a second pine stand results, hardwood succeeding the cutting of pine almost without exception. The better second growth hardwood type is thus decidedly on the increase throughout the region and is growing rapidly in economic importance. Red oak and white ash are the most important species, replacing to a large extent the dying chestnut which, once of great commercial importance, will probably be eliminated from future stands by the chestnut blight (*Endothia parasitica*). Because it most nearly approaches the climax, this type is the easiest to maintain and will be the basis of future forest management on the better soils. Reproduction areas on the Harvard Forest show that under simple forest management red oak and white ash may make up as high as eighty per cent of the total stand. Table I (page 11) will serve to indicate the average composition of natural stands.

In inferior second growth hardwood stands gray birch, red maple and poplar predominate, the percentage of red maple being dependent upon the amount of soil moisture. This type originates on burns or where pine stands under fifty years of age are cut. If left beyond maturity (twenty-five to thirty years for gray birch) the birch disintegrates and

better hardwood seedlings creep in until a stand of the climax or better second growth hardwood type results. If cut before thirty years of age a second inferior stand of sprout origin follows the first.

COLLECTION OF DATA

The forty-eight sample plots, containing over 18,000 trees, upon which the accompanying yield tables are based were carefully selected over an area of 175 square miles in northern Worcester County, Massachusetts. Only fully stocked natural stands of even age were measured. The individual plots were either one-quarter or one-half acre in area, being strips one chain wide and two-and-one-half or five chains long. All trees two inches and over in diameter breast high were calipered and tallied in inch diameter classes by species and the merchantable logs recorded by diameter and species as in timber estimating. The heights of several trees in each crown class were taken and a partial forest description made upon the completion of the strip. Plots ranged from seventeen to seventy-five years of age, the older stands being difficult to find. Stands over seventy-five years of age were unobtainable due to the history of the region and the fact that timber is usually cut before it approaches that age.

CONSTRUCTION OF YIELD TABLES

Of the forty-eight sample plots gathered forty represent the type designated as better second growth hardwoods and eight the type designated as inferior second growth hardwoods. The better second growth hardwood plots were divided into site classes I and II on the basis of average height of the dominant trees. Table I gives the percentages of the various species in mixture on the sample plots, classified as to type and site class.

TABLE I. PERCENTAGE OF THE VARIOUS SPECIES IN MIXTURE, CLASSIFIED AS TO TYPE AND SITE CLASS

	Red Oak	Red Maple	Hard Maple	Gray Birch	Paper Birch	Yellow Birch	Beech	Chest-nut	Bass-Wood	Pop-lar	White Ash	Mis-cell.[1]
Better Hwd.												
Qual. I	27	15	3	0	2	8	2	6	9	7	15	6
Qual. II	20	12	6	0	8	10	7	5	3	8	14	7
Inferior Hwd.	2	24	2	38	3	4	0	1	0	15	1	10

The question of handling chestnut as a species in the construction of the yield tables presented the greatest difficulty encountered, for while all indications are that future stands will contain no merchantable trees of this species it is important in the majority of the present stands. By careful selection of the plots the number of chestnut trees was reduced to six per cent or less, though they might make up as high as ten per cent of the volume. An examination of the tally sheets of all plots showed the chestnut to exceed the oak on the same plot by two diameter classes. That is, if the diameters of the oaks on a given plot ranged from five to nine inches with the average 7.2 inches, the diameters of the chestnuts on the same plot were found to range from 9–11 inches with the average at 9.2 inches. Moreover, measurements of projected crown areas showed that the crown of a 9.2 inch chestnut, due to difference in habit of the species, occupied approximately the same space in the dominant stand as the crown of a 7.2 inch oak. This was taken to indicate that where chestnut trees now occur, oaks two inches less in diameter may occur in future stands. That they will occur in many instances seems almost certain since oak is the most abundant species in present stands where the percent-

[1] Under miscellaneous are included all species whose representation in the plots of any one type or site class is less than five per cent of the total number of trees. These species are: — white oak, black cherry, pignut hickory, white pine, hemlock, elm, butternut, hop hornbeam, black birch, flowering dogwood and shad bush.

age of chestnut is low. As will appear later, even if species other than red oak take the place of chestnut the difference in volume production will not be greatly changed. By careful selection of plots error due to the presence of chestnut was reduced to a small percentage. By reducing the diameters of the few chestnuts on the plots by two diameter classes it was practically eliminated.

The red maple, which is a considerable element in all stands, produces good cordwood, but many trees are too poor in quality to yield saw timber. Species such as hornbeam, shad bush, dogwood, etc., were limited to the lower diameter and suppressed crown classes and were insignificant in volume production.

Table II gives the normal yield per acre in cords and cubic feet of fully stocked natural stands of second growth better hardwoods. All trees two inches and over in diameter breast high are included. But two site classes exist. The thin-soiled, bouldery ridge-tops of third quality, because of their low yield per acre and inaccessibility have never been clear cut, and on sandy soils, deficient in organic content and moisture, the competition of white pine and inferior hardwoods is such as to exclude the better hardwoods.

In discussing the construction of the tables the various columns will be taken up separately giving the methods used in obtaining yield table values and their application.

Basal Area. Omitted in the majority of American yield tables, basal area is always desirable and is essential unless both the number of trees per acre and the average diameter are given, in which case it may be computed. Basal area, not trees per acre, is the criterion of density of stocking on similar sites and is therefore indispensable. The percentage density of stocking of a given stand results from dividing the basal area of a representative acre of that stand by the normal basal area for the site as given in the yield table, site being determined by the average height of the dominant trees.

TABLE II. NORMAL YIELD PER ACRE IN CUBIC FEET AND CORDS OF BETTER SECOND GROWTH HARDWOOD STANDS IN CENTRAL NEW ENGLAND

Site Class I

(All trees 2 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. feet	Height in feet	D.B.H. in inches	Volume per acre cubic feet	Volume per acre cords	Forest form factor
20	1250	66.0	27.1	3.11	1041	15.80	.582
25	1120	90.8	33.0	3.86	1625	23.71	.542
30	1010	107.2	37.5	4.41	2150	29.75	.501
35	900	119.9	41.5	4.94	2628	34.96	.503
40	800	130.2	45.0	5.46	3058	39.63	.520
45	700	139.7	48.2	6.05	3495	44.03	.520
50	610	148.0	50.7	6.69	3898	48.00	.520
55	525	155.7	53.1	7.37	4298	51.84	.520
60	450	162.5	55.4	8.14	4677	55.50	.520
65	390	169.0	57.8	8.91	5068	59.25	.520
70	340	175.1	59.8	9.72	5462	62.75	.522
75	300	180.9	61.9	10.51	5833	66.18	.521
80	270	186.3	64.0	11.25	6200	69.50	.520

Site Class II

(All trees 2 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. feet	Height in feet	D.B.H. in inches	Volume per acre cubic feet	Volume per acre cords	Forest form factor
25	1360	59.8	27.8	2.84	982	14.65	.593
30	1235	77.9	31.8	3.40	1380	20.40	.557
35	1125	91.1	34.8	3.86	1798	25.48	.567
40	1030	101.6	37.4	4.25	2180	29.53	.574
45	940	110.3	39.8	4.66	2534	33.04	.577
50	855	117.9	41.5	4.94	2828	35.98	.580
55	775	124.6	42.8	5.43	3118	38.55	.584
60	700	130.7	44.2	5.85	3375	41.08	.584
65	630	136.6	45.3	6.31	3638	43.42	.587
70	565	142.2	46.3	6.79	3895	45.61	.592
75	500	147.7	47.0	7.36	4146	47.75	.598
80	440	153.0	47.6	7.98	4390	49.80	.601

Diameter Breast High. The average, breast-high diameter of all trees over two inches was obtained by dividing the basal area per acre by the number of trees per acre. Two factors cause variation in the average diameters of trees in fully stocked stands of the same age. First, the normal basal area and crown cover may exist when the dominant stand contains few trees of large diameter and crown spread or many trees with small diameters and crowns: second, there may or may not be a large number of suppressed and intermediate trees in the stand. If there is the diameter of the average tree is greatly reduced.

Cubic Foot and Cord Volume per Acre. Several methods of obtaining volumes in the construction of yield tables are recognized. Perhaps the most common is that of the mean sample tree. This method involves the computation of the mean at the time of measuring the sample plots and the cutting and partial stem analysis of several sample trees for each plot. In the present case, a red maple volume table, made on the Harvard Forest,[1] and giving volumes in cubic feet and cords, was used. Its applicability was established by the following test. A quarter acre sample plot was carefully laid out in a twenty-eight year old better second growth hardwood stand on quality one site. Its approximate composition was red oak thirty per cent, red maple twenty-five per cent, chestnut fifteen per cent, yellow birch eight per cent and miscellaneous species twenty-two per cent. All trees over two inches were calipered and tallied in inch diameter classes and a number of heights taken. Three inch diameter classes were then formed and the height and diameter of the mean sample tree for each of these was determined. At least three mean sample trees for each class were then felled and cut into bolts four feet two inches long, the

[1] Original: A Volume Table For Red Maple on the Harvard Forest, E. E. Carter, Bulletin of the Harvard Forestry Club, vol. 2, 1913.

Revised: Volume Table for Red Maple on the Harvard Forest (Revised and Enlarged by E. E. Carter in 1915). U. S. D. A. Bull. 285, The Northern Hardwood Forest: Its Composition, Growth and Management, pp. 61–63.

middle and small end diameter of each bolt being recorded. The cubic foot volumes of the sample trees were then calculated by Newton's formula $(B+4b_{\frac{1}{2}}+b)\frac{h}{6}$. The cubic foot and cord volumes of the plots were calculated by the use of the volumes of the mean sample trees. The cubic foot and cord volumes were also computed by both the original and the revised red maple volume tables using the original tally of the plot to find the number of trees in each diameter class by which the volume of a single tree in that class, as found in the red maple table, was multiplied. The quarter-acre plot was then cut clear and piled as four-foot wood, the measurement of the piled wood giving the actual volume of the stand. Results of the test are given below.

Method	Yield per ¼ acre	Error
Actual volume cut	5.725 cords	
Revised volume table	5.772 "	.83 %
Original volume table	5.822 "	1.70 %
Mean sample tree method	5.935 "	3.84 %

This test shows not only that the use of the volume table was more accurate than even a very carefully executed sample tree method but also that with even-aged second growth stands it can be applied according to diameter breast high and height regardless of species. Cubic foot and cord volumes in the yield tables are derived by harmonizing with a curve the sums of the volumes of the individual trees on these plots as determined by the revised red maple volume table.

Forest Form Factor. A forest form factor is the ratio between the volume of a stand and that of a cylinder having the basal area of the stand and the height of the average tree. It is most easily expressed in cubic feet. Those here given are breast-high, merchantable, cubic foot forest form factors obtained by multiplying the basal area of the stand by the average height of the dominant trees and dividing the yield per acre in cubic feet, as given in the yield table, by the

resulting number. Such a form factor is admittedly an arbitrary ratio being dependent upon the basal area of all trees in the stand and the average height of the dominant trees only. Its use is simplified, however, in that the cubic foot volume of the stand may be calculated directly by the formula V = BHF in which V = volume of stand in cubic feet, B = breast-high basal area, H = average height of dominant tree and F = forest form factor, the average height of the dominant tree being less variable than the average height of all trees. It will be noted that the first two form factors in Table II are high, but the ratio falls rapidly. This is explained by the fact that trees other than dominants are growing into the lower diameter limits of the table and, other things being equal, the form factor is higher the more nearly the average height upon which it is based approaches the average height of all the trees in the stand. Later in the life of the stand the form factor is much more constant. Table IV in which the diameter limit is the same closely resembles Table II, while reference to Table III will show that with a high minimum diameter limit the period during which the form factor decreases is greatly prolonged. This is explained by the fact that suppressed and intermediate trees (*i. e.*, trees with less than the average height of the dominants) are growing into the lower diameter limit of the table for a longer period.

Increment. Properly included in yield tables but easily derivable from data given, increments are omitted in order that the tables may not prove cumbersome.

Table III gives the normal yield in board feet and additional cords, cubic feet and cords of better second growth stands. It differs from Table II in that the lower diameter limit is seven instead of two inches and board foot volumes are included. It is based on the same plots as Table II the trees between two and seven inches being omitted in the computations. Methods of construction were the same as for Table II.

TABLE III. NORMAL YIELD PER ACRE IN BOARD FEET AND ADDITIONAL CORDS, CUBIC FEET AND CORDS OF BETTER SECOND GROWTH HARDWOOD STANDS IN CENTRAL NEW ENGLAND

Site Class I

(All trees 7 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. ft.	Height in feet	D.B.H. in inches	Volume per acre cu. ft.	Volume per acre cords	Volume per acre board feet	Volume per acre additional cords	Forest form factor
30	37	10.7	51.9	7.28	350	5.2	1,460	1.4	.636
35	147	48.4	57.0	7.86	1280	13.8	2,900	6.4	.465
40	186	70.7	61.3	8.45	1950	21.3	4,720	9.2	.450
45	205	89.4	64.8	9.00	2549	28.3	7,130	10.0	.440
50	216	105.8	68.1	9.48	3120	34.8	10,310	8.3	.433
55	223	120.9	71.0	9.97	3680	40.6	13,160	6.3	.429
60	226	135.4	73.6	10.53	4240	46.1	15,620	5.6	.426
65	227	150.1	75.9	11.08	4810	51.2	17,850	5.4	.422
70	226	164.3	78.0	11.59	5360	56.0	19,830	5.3	.419
75	224	178.6	79.8	12.10	5900	60.8	21,700	5.2	.415
80	220	192.4	81.5	12.62	6450	65.6	23,400	5.3	.411

Site Class II

(All trees 7 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. ft.	Height in feet	D.B.H. in inches	Volume per acre cu. ft.	Volume per acre cords	Volume per acre board feet	Volume per acre additional cords	Forest form factor
35	56	16.0	49.4	7.25	530	6.7	800	4.7	.671
40	104	35.0	54.5	7.85	1010	14.0	1,920	9.1	.529
45	133	51.3	56.7	8.41	1460	19.7	3,250	11.4	.502
50	157	66.0	59.4	8.78	1870	24.6	4,780	12.3	.477
55	175	79.9	61.6	9.15	2250	29.1	6,600	12.2	.459
60	188	92.8	63.2	9.51	2620	32.8	8,660	10.2	.447
65	197	105.7	64.4	9.90	2970	36.4	10,850	8.6	.437
70	203	117.9	65.4	10.32	3310	39.7	12,710	7.1	.429
75	206	130.0	66.2	10.75	3660	42.7	14,220	6.2	.425
80	207	141.8	66.8	11.21	4020	46.0	15,380	6.1	.424

Number of Trees per Acre. It will be noted that there are more trees per acre on site quality one than on two. This is due to the high diameter limit. While there are actually more trees per acre on quality two sites at a given age, as will be seen by reference to Table II, not so many grow into the limits of Table III in a given period of years, so that the number of trees included is greater on the better sites.

Board Foot Volumes. In obtaining board foot volumes the present milling practice throughout the region was carefully taken into account. Volumes are, therefore, actual not theoretical, and as they are based wholly on natural stands, represent a conservative minimum for fully stocked stands under forest management. Practically all hardwood is sawed through and through into round-edged lumber. Any tree which will given an eight foot log out of which a board with a minimum face of five inches can be sawed is considered merchantable. At the time of measuring the plots the top diameter and length of each log contained in the individual trees was calculated and recorded with due allowance for crook and defect. Board foot volumes of logs were computed by the use of Clark's International Log Rule which is shown by the sawmill practice of the region to be conservative. Mill tally studies on the Harvard Forest show slightly higher values than those in Clark's rule. In calculating the additional cords six board feet to the cubic foot and sixty-five cubic feet to the cord were assumed. This figure is admittedly but a rough estimate. Under favorable market conditions the cordwood in the trees two to seven inches in diameter, which is omitted in the table, could be utilized. The volume of this product may be found by subtracting the cord volumes given in Table III from those given in Table II for the same age and site class.

Table IV gives the normal yield in cubic feet and cords of inferior second growth hardwood stands. All trees two inches and over in diameter breast high are included. But one site quality, an average between quality one and quality two for

TABLE IV. NORMAL YIELD IN CUBIC FEET AND CORDS OF INFERIOR SECOND GROWTH HARDWOOD STANDS IN CENTRAL NEW ENGLAND

(All trees 2 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. feet	Height in feet	D.B.H. in inches	Volume per acre cubic feet	Volume per acre cords	Forest form factor
17	1050	42.2	28.6	2.71	670	10.40	.555
18	1535	65.7	29.3	2.80	830	14.15	.431
19	1640	73.8	29.9	2.87	990	16.60	.449
20	1708	79.2	30.5	2.92	1130	18.06	.460
21	1750	84.0	31.1	2.95	1230	18.95	.471
22	1774	85.5	31.6	2.98	1300	19.54	.481
23	1778	87.0	32.1	3.01	1360	19.97	.487
24	1768	88.0	32.5	3.03	1400	20.30	.490
25	1743	88.2	32.9	3.05	1430	20.53	.492
26	1710	87.9	33.3	3.07	1440	20.72	.493
27	1671	87.4	33.6	3.10	1450	20.86	.494
28	1623	86.8	33.9	3.13	1455	20.88	.495
29	1575	86.1	34.1	3.17	1460	20.75	.494
30	1515	85.3	34.4	3.21	1460	20.63	.494

this type, is given. The construction of the table is similar to that of Table II.

Number of Trees per Acre. The gradual increase in the number of trees per acre between the ages of seventeen and twenty-three years is due to the fact that many trees are growing into the lower diameter limit of the table during this period — exactly the same effect as that produced by a high diameter limit in the case of Table III. After thirty years gray birch rapidly deteriorates, the rate of reduction in volume of the stand being dependent upon the percentage of this element in its composition. Cord volume falls off while cubic foot volume maintains a slight increase because more cubic feet of solid wood are required to make a cord as average diameters of trees become greater. The continuance of rise in volume after the culmination of basal area is due to the

fact that gray birch has relatively less merchantable length than all other hardwood species for its total height. For this reason it is an exception to the conclusion that the volume of a tree of given height and diameter in cords and cubic feet is the same, regardless of species.

APPLICABILITY OF TABLES

The individual plots from which the better hardwood tables were derived varied greatly in the proportions of the various species in mixture. Since this was found to have little or no effect on the volumes of these plots it is fair to suppose that the tables are applicable to a wide variety of mixtures. The test of the Harvard Red Maple Volume Table, described on page 14, indicates that even-aged second growth hardwoods on similar sites have much the same form regardless of species. Mill tally scales also appear to bear out this belief. If this is true, the present tables should be capable of wide use both in the determination of the present and future yields of individual stands, and in more general computations relating to the stand and growth of hardwoods throughout the region.

BOTANICAL NAMES OF SPECIES MENTIONED

(Botanical names are those given in Gray's *New Manual of Botany*, Seventh Edition)

Basswood. *Tilia americana*, L.
Beech. *Fagus grandifolia*, Ehrh.
Black Ash. *Fraxinus nigra*, Marsh.
Black Birch. *Betula lenta*, L.
Black Cherry. *Prunus serotina*, Ehrh.
Black Oak. *Quercus velutina*, Lam.
Butternut. *Juglans cinerea*, L.
Chestnut. *Castanea dentata*, (Marsh.) Borkh.
Chestnut Oak. *Quercus Prinus*, L.
Elm. *Ulmus americana*, L.
Flowering Dogwood. *Cornus florida*, L.
Gray Birch. *Betula populifolia*, Marsh.
Hard Maple. *Acer saccharum*, Marsh.
Hemlock. *Tsuga canadensis*, (L.) Carr.
Hop Hornbeam. *Ostrya virginiana*, (Mill.) K. Koch.
Paper Birch. *Betula alba var. papyrifera*, (Marsh.) Spach.
Pignut Hickory. *Carya glabra*, (Mill.) Spach.
Poplar. *Populus tremuloides* and *P. grandidentata*, Michx.
Red Maple. *Acer rubrum*, L.
Red Oak. *Quercus rubra*, L.
Red Pine. *Pinus resinosa*, Ait.
Red Spruce. *Picea rubra*, (DuRoi) Dietr.
Scarlet Oak. *Quercus coccinea*, Muench.
Shad Bush. *Amelanchier* sp.
Tupelo. *Nyssa sylvatica*, Marsh.
White Ash. *Fraxinus americana*, L.
White Oak. *Quercus alba*, L.
White Pine. *Pinus strobus*, L.
Yellow Birch. *Betula lutea*, Michx. f.